REMARKS

Claims 1-57 are present in this application. Claims 1-15 and 39-56 have been withdrawn. Of the examined claims, claim 16 is independent. Claim 57 is new.

Allowable Subject Matter

Applicants thank the Examiner for indicating that claims 22, 28, and 37 are allowable.

Claim Rejection - 35 USC 102(b); Spitzer

Claims 16-21, 23, 27, 29-34 have been rejected under 35 U.S.C. 102(b) as being anticipated by WO/93/15589 ("Spitzer"). Applicants respectfully traverse this rejection.

The Office Action relies on Figure 25 and the associated description on page 52 of Spitzer for teaching the elements of claim 16. Spitzer appears to teach a thin film of single-crystal silicon 714 attached to a glass substrate 712. However, Applicants disagree that Spitzer teaches a non-single-crystal silicon thin-film device attached to a different area of the insulating substrate on which the single-crystal thin film device is formed. In particular, Applicants submit that Spitzer's Figure 25 does not show a non-single-crystal silicon thin-film device.

Summary of the Present Claimed Invention

Known prior art techniques for forming single-crystal silicon thin film devices involved applying heat to amorphous silicon or polycrystalline silicon to crystallize the silicon into single crystal silicon thin film, or applying a preformed single-crystal silicon thin film device to an insulating substrate using an adhesive. In the former case, a semiconductor device cannot be formed consisting both of a non-single-crystal silicon thin film device and a single-crystal silicon thin film device on the same insulating substrate. In the later case, applying a single-crystal silicon thin film device to an insulating substrate using an adhesive results in insufficient bonding strength.

In the present invention, a single-crystal silicon thin film device is bonded to an insulating substrate, consisting of a non-single-crystal thin film device, without using an adhesive. Thus, the present invention achieves a semiconductor device consisting of both a single-crystal silicon thin film device and a non-single-crystal silicon thin film device on the same insulating substrate. By forming semiconductor device of a single-crystal silicon thin film device on the same substrate as a non-single crystal silicon thin film device, a device requiring high performance, such as a timing controller, can be combined on the same substrate with a device not requiring such high performance, at a high ratio of performance to cost.

Spitzer

Spitzer is directed to single crystal arrayed devices (Title). Spitzer discloses a fabrication method for such devices which forms large area semiconductor films of single crystal silicon, separates the films from an epitaxial processing substrate, and mounts them on glass or other suitable optically transmissive materials (page 3, paragraph beginning on line 25). Functional devices are at least partially fabricated prior to separation and then transferred to glass, as the final panel substrate.

Spitzer teaches use of the silicon-on-insulator process for forming a single crystal film on an insulating substrate from which it can be released (paragraph bridging pages 4-5). In particular, Spitzer teaches as a preferred embodiment use of Isolated Silicon Epitaxy (ISE) to produce a thin film of high quality Si on a release layer. The ISE process includes depositing a non-single crystal material such as amorphous or polycrystalline silicon on the release layer which is then heated to crystallize the material to form an essentially single crystal silicon (page 5, first full paragraph). The use of the release layer enables the film and the circuit to be released using oxides without harm to the circuits.

Another preferred embodiment applies the process to fabricating a light valve matrix (i.e., pixel array; see page 3, lines 10-14) and transferring it to a support structure as disclosed with respect to Figures 25A to 25C (pages 52-55). The

process starts with a silicon wafer 718 upon which an oxide layer 716 and a thin film of polycrystalline silicon or amorphous silicon 714 is formed using the ISE process into a single-crystal silicon thin film (page 52, lines 4-8). Circuits are formed in the thin film (lines 8-13). A wafer is transferred to a substrate transfer body 712, e.g., of glass, using an adhesive 721. Spitzer also discloses that various other bonding procedures could be used for mounting on substrates, including electrostatic bonding, Van der Waal's forces or a eutectic alloy for bonding (page 4, lines 3-7). The wafer is then cleaned and the native oxide 718 is etched off until the silicon is completely gone. Thus, thin films 714 are transferred to respective glass substrates 712 to form a light valve matrix.

Differences over Spitzer

The embodiment related to Figure 25 uses a process such as ISE or CLEFT. The embodiment has a starting structure of a wafer 718 upon which a thin film of poly-Si, a-Si or x-Si 714 is formed using the ISE or CLEFT process. According to page 5, first full paragraph in Spitzer, the ISE process or CLEFT process is applied to form a thin film of polycrystalline silicon or amorphous silicon into a single-crystal silicon thin film. For example, on page 22, lines 9-16, Spitzer discloses that the ISE or CLEFT process is used to form sheets of essentially single crystal material. According to the embodiment in Figure 25, a resulting wafer is attached to a glass

substrate 712. Each of the devices 740, 762, 751, and 720 are all formed by the ISE or CLEFT process. Thus, it can be seen that all of the circuits (i.e., pixel electrodes, TFT's Si drivers and Si logic circuits) formed in the thin film are essentially single-crystal thin-film devices.

Thus, Spitzer fails to teach or suggest at least the claimed "wherein the non-single-crystal silicon thin-film device and the single-crystal silicon thin-film device are provided in different areas of an insulating substrate." Applicants submit that Spitzer fails to teach each and every claimed element. For at least this reason, Applicants request that the rejection be reconsidered and withdrawn.

Further with respect to claim 17, Applicants submit that Spitzer fails to teach at least the claimed single-crystal thin-film bonded with the insulating substrate via the intervening inorganic insulating film.

The Office Action states that the adhesive 721 of Spitzer teaches the claimed "intervening inorganic insulating film." Although the adhesive of Spitzer is for bonding the single-crystal silicon thin-film device to an insulating substrate, Spitzer's adhesive 721 is preferably made of epoxy, i.e., an organic compound. Thus, Spitzer does not actually teach an intervening inorganic insulating film. For at least the above reasons,

Applicants request that the rejection of claim 17 be reconsidered and withdrawn.

New Claim

A feature of the present invention that enables a single-crystal silicon thin-film device to be mounted on the same substrate with a non-single-crystal silicon thin-film device is due to the improved bond between the single-crystal silicon substrate and the insulating substrate. Bonding of a single-crystal silicon substrate to an insulating substrate can be made using an adhesive, as shown in Spitzer. A problem with bonding using the adhesive has been that it had low heat resistance. In an alternative approach, a problem with using an oxidized film has been that it resulted in an irregular surface leading to deterioration of the bonding. The present invention, as recited in new claim 57, solves previous problems by forming a "siloxane bond" between the single-crystal silicon substrate, at the side having the oxidized film, and an inorganic insulating film (specification at page 12).

Conclusion

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Robert W. Downs (Reg. No. 48,222) at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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